UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2010/2011

November 2010

EBP 201/3 - Polymer Synthesis
[Sintesis Polimer]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains TEN printed pages before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper consists of SEVEN questions.
[Kertas soalan ini mengandungi TUJUH soalan.

Instruction: Answer **FIVE** questions. If candidate answers more than five questions only the first five questions answered in the answer script would be examined.
*[**Arahan**: Jawab **LIMA** soalan. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

The answers to all questions must start on a new page.
[Mulakan jawapan anda untuk semua soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

In the event of any discrepancies, the English version shall be used.
[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

1. [a] Compare the effect between initiator concentration and addition of chain transfer agent on the rate and degree of conversion of a chain growth polymerization.

Bandingkan kesan kepekatan pemula dan penggunaan agen pemindahan rantai ke atas kadar dan darjah penukaran bagi pempolimeran pertumbuhan rantai.

(30 marks/*markah*)

[b] Average molecular weight of polystyrene polymerised in benzene solvent is 21000 but in toluene solvent its average molecular weight is 9500. Explain this statement.

Berat purata molekul bagi polistirene menggunakan pelarut benzena adalah 21000 manakala berat purata molekul adalah 9500 bila menggunakan pelarut toluena. Jelaskan pernyataan ini.

(30 marks/*markah*)

[c] Branching commonly occur on polyethylene during its free radical polymerisation. Give an explanation for this statement.

Pempolimeran radikal bebas bagi polietilena selalunya menghasilkan hasil yang bercabang. Berikan penjelasan tentang pernyataan tersebut.

(40 marks/*markah*)

2. Copolymerisation between monomer A and B through radical mechanism can be predicted using the following formula:

Pengkopolimeran antara monomer A dan monomer B melalui mekanisme radikal boleh ditentukan menggunakan persamaan berikut:

$$r_A = \frac{Q_A}{Q_B} \exp[-e_A(e_A - e_B)]$$

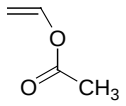
(a) Describe briefly the use of this formula to predict types of copolymerisation.

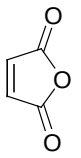
Jelaskan secara ringkas kegunaan persamaan ini bagi menentukan jenis pengkopolimeran.

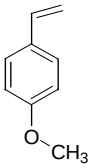
(20 marks/*markah*)

(b) Given 3 monomers as below:

Diberi 3 monomer seperti berikut:







(i) Arrange them in increasing order of Q values

Susun secara menaik nilai Q

(ii) Arrange them in increasing order of e values

Susun secara menaik nilai e

(40 marks/*markah*)

(c) Predict from the above given monomer pairs which would be formed.

Ramalkan antara pasangan monomer-monomer di atas yang akan membentuk

(i) block copolymer

kopolimer blok

(ii) random copolymer

kopolimer rawak

(40 marks/*markah*)

3. [a] Describe what is meant by autocatalysis during polyesterification between adipic acid and ethylene glycol.

Perihalkan apa yang dimaksudkan dengan pemangkinan-auto dalam poliesterifikasi asid adipik dengan etilena glikol

(40 marks/*markah*)

[b] Given the degree of conversion, P, of the above polymerisation against time at stoichiometric ratio of monomers as in the table below. The initial molarity for the adipic acid used is 3.0 M.

Time/mins	0	10	20	30	40
P	0	0.67	0.79	0.87	0.89

(i) Determine the rate constant hence order of the reaction.

(ii) Calculate the remaining adipic acid after 25 and 50 minutes.

Diberi darjah penukaran, P, bagi polimer di atas melawan masa adalah seperti dalam jadual berikut.

Time/mins	*0*	*10*	*20*	*30*	*40*
P	*0*	*0.67*	*0.79*	*0.87*	*0.89*

(i) Tentukan pemalar kadar seterusnya tertib tindakbalas

(ii) Hitung asid adipik yang tertinggal selepas 25 dan 50 minit bertindakbalas.

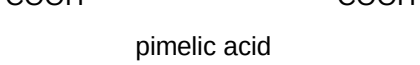
(60 marks/*markah*)

4. [a] Derive Carothers Equation.

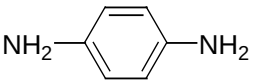
Terbitkan persamaan Carothers.

(20 marks/*markah*)

[b] Polymerisation between pimelic acid and p-phenylenediamine as shown below was performed:



pimelic acid



p-phenylenediamine

Calculate the average molecular weight M_n of product at

(i) 98% conversion with equimolar ratio of monomers

(ii) 98% conversion with mole ratio of the acid to amine 3:2

(iii) At full conversion with mole ratio of acid to amine 3:2

Deduce for any conclusions of the result above.

Pempolimeran antara asid pimelik dan p-fenilenadiamina seperti ditunjukkan di bawah telah dijalankan:

pimelic acid

p-phenylenediamine

Hitung berat purata molekul Mn hasil pada:

(i) 98% penukaran pada nisbah ekuimolar monomer

(ii) 98% penukaran pada nisbah mol asid dengan amina 3:2

(iii) penukaran sepenuhnya pada nisbah asid dengan amina 3:2

Rumuskan beberapa kesimpulan dari pengiraan di atas.

(80 marks/*markah*)

5. Answer all of the following questions:

(a) State 2 factors which affect compositional drift during copolymerization process.

(b) State 2 features in metallocene catalysis which contribute to the control of tacticity.

(c) State 2 features in Ziegler-Natta catalysis which contribute to the control of tacticity.

(d) State 3 disadvantages of solution polymerization.

Jawab kesemua soalan berikut:

(a) Nyatakan 2 faktor yang mempengaruhi anjakan komposisi semasa proses pengkopolimeran.

(b) Nyatakan 2 ciri pada pemangkinan metalosin yang menyumbang kepada pengawalan taktisiti.

(c) Nyatakan 2 ciri pada pemangkinan Ziegler-Natta yang menyumbang kepada pengawalan taktisiti.

(d) Nyatakan 3 keburukan pempolimeran emulsi.

(100 marks/*markah*)

6. [a] The followings are separation techniques used during polymer synthesis.

(i) Suction filtration

(ii) Distillation

(iii) Rotary evaporator

Describe each of these techniques further

Berikut adalah teknik pemisahan yang digunakan dalam sintesis polimer.

(i) Penurasan sedutan

(ii) Penyulingan

(iii) Penyuling putaran

Perihalkan teknik-teknik ini dengan lebih lanjut.

(30 marks/*markah*)

[b] The following describe the procedure to synthesis polyvinyl alcohol from polyvinyl acetate: '30 ml of 1% methanolic NaOH are placed in 500-ml three neck flask, fitted with the stirrer, reflux condenser,and dropping funnel and heated to 50^{o}C in a water bath. A solution of 15 g of polyvinyl acetate in 100 ml ethanol is added dropwise with vigorous stirring for 30 mins. The transesterification set in immediately as indicated by precipitation of polyvinyl alcohol. The powdery precipitate is then collected and washed with methanol and finally dried in vacuum at 30 - 40^{o}C'. Answer the followings:

(i) Draw the experimental set-up for this synthesis.

(ii) Suggest with reason the best separation technique for use to separate the polyvinyl alcohol precipitate from the other reacting products.

(iii) Explain why ethanol is used as the solvent here.

(iv) What is the function of ethanolic NaOH in this procedure?

Berikut adalah kaedah sintesis polivinil alkohol dari polivinil asetat '30 ml dari 1% NaOH beralkohol dimasukkan ke dalam 500 ml kelalang 3-leher yang dilekatkan dengan penggoncang, kondenser refluk dan corong penitis seterusnya dipanaskan ke suhu 50^{o}C dalam kukusan air. 15 g larutan polivinil asetat dalam 100 ml etanol dititiskan ke larutan ini dan dikacau kuat selama 30 mins. Proses transesterifikasi berlaku serta merta berdasarkan pembentukan mendakan polivinil alkohol. Hasil mendakan dikutip dan dicuci dengan metanol seterusnya dikeringkan dalam oven pada suhu 30 - 40^{o}C'.

(i) Lakarkan pasang-atur radas bagi sintesis ini

(ii) Cadangkan berserta alasan teknik terbaik untuk memisahkan mendakan polivinil alkohol dari hasil tindakbalas yang lain.

(iii) Jelaskan kenapa etanol digunakan sebagai pelarut disini.

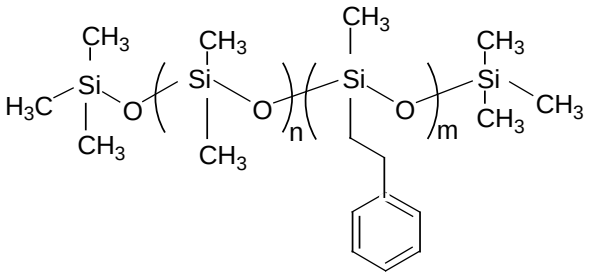
(iv) Apakah fungsi NaOH beralkohol dalam tatacara ini?

(70 marks/*markah*)

7. Show the reaction pathways to synthesis the following polymeric products. Some suggested materials for use are given. State the reaction conditions and you may add any additional materials along the reaction pathways as required.

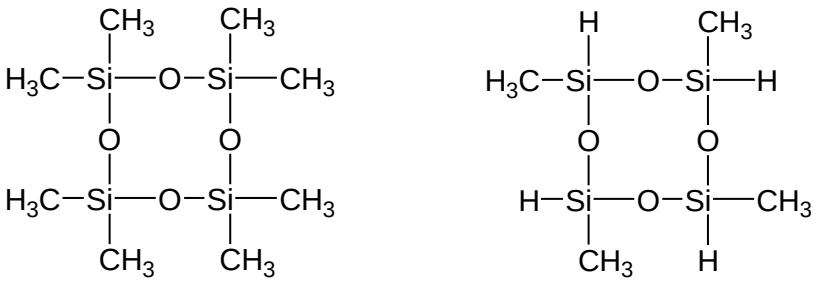
Tunjukkan laluan tindakbalas untuk menghasilkan polimer yang berikut. Diantara bahan permulaan ada dicadangkan. Nyatakan keadaan tindakbalas dan anda boleh mencadangkan bahan tambahan untuk digunakan dalam laluan tindakbalas ini.

(a)



Suggested starting materials:

Bahan pemula yang dicadangkan:



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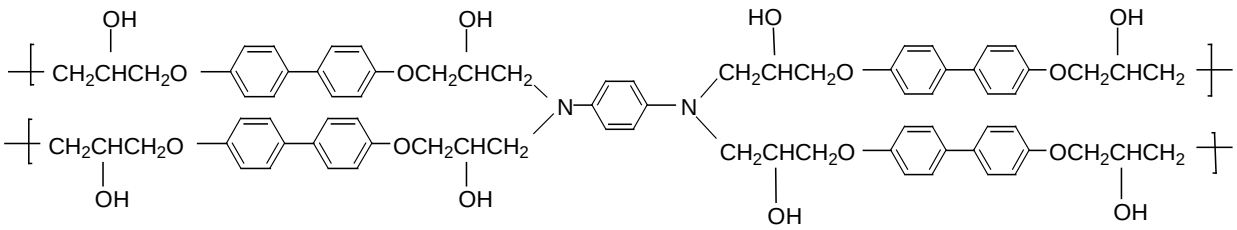
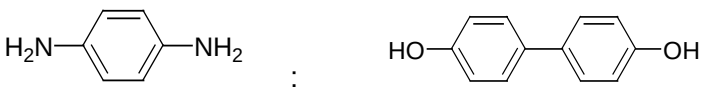


Suggested starting materials:

Bahan pemula yang dicadangkan:



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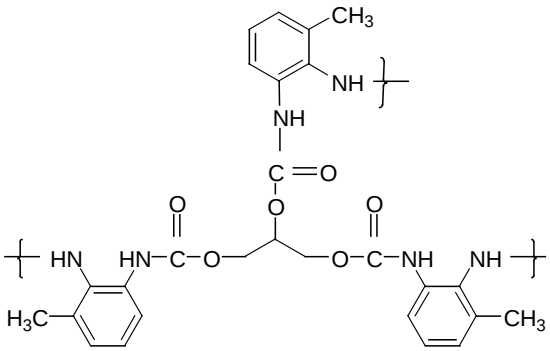
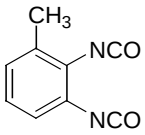
(c)



Suggested starting material:

Bahan pemula yang dicadangkan:



(100 marks/*markah*)

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